become exposed to the action of air and water. In this way the solid nucleus of igneous rock became surrounded with a deep layer of disintegrated and water-impregnated material, the ruins of its former envelope, and the chaotic mass from which, under the influence of heat from below and of air and water from above, the world of geologic and of human history was to be evolved.

It must be borne in mind that water under pressure and at high temperatures, develops extraordinary solvent powers; while from what has already been said of the influence of pressure in favoring solution, it will be seen that the weight of the overlying mass becomes an efficient cause of the liquefaction of the lower portions of the sedimentary material. Time is wanting to discuss the great forces which from early geologic periods have been active in transferring sediments, alternately wasting and building up continents. By the depression of the yielding crust beneath regions of great accumulation there follows a softening of the lower and of the more fusible strata, while the great mass of more silicious rocks becomes cemented into comparative rigidity, and finally, as the result of the earth's contraction, rises a hardened and corrugated mass, from whose irregular erosion results a mountainous region.

Those strata, which from their composition yield under these conditions the most liquid products, are, it is conceived, the source of all plutonic and volcanic rocks. Accompanied by water, and by difficultly coercible gases, they are either extravasated among the fissures which form in the overlying strata, or find their way to the surface. The variations in the composition of lavas and their accompanying gases in different regions, and even from the same vent at different times, are strong confirmations of the truth of this view, to which may be added the fact that all the various types of lava are represented among aqueous sedimentary rocks, which are capable of yielding these lavas by the process of fusion."

Geology of Colorado and New Mexico.* — With the small appropriation of ten thousand dollars, Dr. Hayden appears to have traversed in one season a very large territory, made extensive collections and a series of valuable and minute observations upon the geological structure of the country. The report of these is accompanied by a report upon "The Mines and Minerals of Colorado," by Professor Frazer, which gives a fair and candid statement of the mineral wealth of Colorado and New Mexico; and by a report upon the Agricultural Resources of Colorado.

These various reports cannot fail of attaining the object for which they were written, since in them every one interested in the future development of these territories may find reliable and unprejudiced information with regard to their natural resources. The sum of money appropriated for this purpose was so small that Dr. Hayden could not have accomplished a large portion of his explorations without their assistance. The appropriation of ten thousand dollars, by the central government, to explore two territories, while a state is spending annually more than twice that amount, per annum, upon a single institution, might excite some surprise and confusion in the minds of a foreigner.

The route lay along the eastern foot of the Rocky Mountains, from Cheyenne, in Wyoming Territory, to Santa Fè, the Middle Park having been explored by a lateral excursion from Denver City. Returning from Sante Fè they returned to Denver by passing up the Rio Grande and crossing the Rocky Mountains through the South Park. The explorer's remarks with regard to the superficial deposits are very interesting, and their general importance as an explanation of the origin of some of the most interesting localities is our justification for the following extract:

* Preliminary Field Report of the U. S. Geological Survey of Colorado and New Mexico. By Dr. F. V. Hayden. Washington, D. C. 8vo. 1869.

"With the commencement of the tertiary was ushered in the dawn of the great lake period of the West. The evidence seems to point to the conclusion that from the dawn of the tertiary period, even up to the commencement of the present, there was a continuous series of fresh-water lakes all over the continent west of the Mississippi River. Assuming the position that all the physical changes were slow, progressive, and long-continued, and that the earlier sediments of the tertiary were marine, then brackish, then purely fresh water, we have through them a portion of the consecutive history of the growth of the western continent, step by step, up to the present time. The earliest of these great lakes marked the commencement of the tertiary period, and seems to have covered a very large portion of the American continent west of the Mississippi, from the Arctic Sea to the Isthmus of Darien.

About the middle of the tertiary period the second extensive lake commenced in the West, which we have called the White River tertiary basin. We believe that it commenced its growth near the south-eastern base of the Black Hills, and gradually enlarged its borders. I am inclined to think that this lake has continued on, almost or quite up to the commencement of the present period; that the light colored arenaceous and marly deposits in the Park of the Upper Arkansas, in the Middle Park, among the mountains at the source of the Missouri River, in Texas and California, and Utah, are all later portions of this great lake. The upper miocene or pliocene deposits in the Wind River Valley, near Fort Bridger, and on the divide between the Platte and the Arkansas Rivers, were undoubtedly synchronous, though perhaps not connected with this great basin. Every year, as the limits of my explorations are extended in any direction, I find evidences of what appear to be separate lake basins, covering greater or less areas, and bearing intrinsic proof, more or less conclusive of the time of their existence. I have given in this place the above brief description of the various geological formations as I have studied them in the West, in order that my subsequent remarks on these formations in their southern extension may be more clearly understood. Constant reference will be made to rocks as they have been seen in the far North and West, in order that the story of their geological extension may be linked together."

Dr. Hayden also speaks of having met with vast quantities of true drift material which he regards as originating from the neighboring mountains. "The superficial deposits at the very margins of the mountains is composed of very coarse materials, sometimes immense quantities of all kinds, but slightly worn; but proceeding from the base of the mountains, the rocks become smaller and more rounded, until they pass into small pebbles, mingled with loose sand. The phenomena of erosion, as seen at the present time, all along the flanks of the mountains, in the plains, in the channels of streams, point clearly to a vastly greater quantity and force of water than exist anywhere at the present time." A page is devoted to an account of the general structure of the mountains which Dr. Hayden's long familiarity with them enables him to condense into so brief a space:

"It is now well known that the great Rocky Mountain system is not composed of a single range, but a vast series of ranges, covering a width of six hundred to one thousand miles. There are also two kinds of ranges, one with a granitoid nucleus, with long lines of fracture, and in the aggregate possessing a specific trend; the other has a basaltic nucleus, and is composed of a series of volcanic cones or outbursts of igneous rocks, in many cases forming those saw-like ridges or sierras, as the Sierra Nevada, Sierra Madre, etc. Along the eastern portion of the Rocky Mountains, from the north line to New Mexico, the ranges with a granitoid nucleus prevail. Each one of the main ranges is sometimes split up into a number of fragments, which locally may vary somewhat from a definite direction, but the aggregate trend will be about north-west and south-east.

As I have before stated, each one of the main ranges seems to me to form a gigantic anticlinal with a principal axis of elevation, and the lower parallel ranges descending like steps to the plains, or to the synclinal valley. If, for example, we were to study carefully one of the minor mountain ranges, as the Black Hills of Dakota, or the Laramie range, where the system is very complete and regular, we should find a central granitic axis, and on each side a series of granitic ridges parallel with it, and in the aggregate trending nearly north and south. And

on the eastern portion of the anticlinal, the east side of the minor ridges slopes gently down, while the west side is abrupt; and on the western portion *vice versa*. But if we take the ridges singly and examine them, we shall find in most cases that the aggregate trend is nearly north-west and south-east. The consequence is, that as we pass along under the eastern flanks of the mountain from north to south, these minor ranges or ridges present a sort of "*en echelon*" appearance; that is, they run out one after the other in the prairies, preserving the nearly north and south course of the entire system. Not unfrequently a group or several of these ridges will run out at the same time, forming a huge notch in the main range. This notch in most cases forms a vast depression with a great number of side depressions or rifts in the mountains, which give birth to a water system of greater or less extent. Such, for example, is the notch at Cache a la Poudre, Colorado City, Canon City, on the Arkansas River, and other localities. If we were to examine the excellent topographical maps issued by the War Department, which are beyond comparison the most correct and most scientific of our Rocky Mountain region in existence, we should at once note the tendency of all the minor ranges, with a continued line of fracture and a granitic nucleus, to a south-east and north-west trend; sometimes it is nearly north and south, and then these ranges pass out or come to an end without producing any marked influence on the topography, except, perhaps, some little stream will flow down into the plain through the monoclinal rift. But when several of these minor ranges come to an end together, an abrupt jog of several miles towards the west is caused. Then frequently as the range dies out, a local anticlinal or a semi-quaquaversal dip is given to the sedimentary beds. Between the notches or breaks in the mountains, the belt of ridges or "hog-backs" becomes very narrow, sometimes even hardly visible, and sometimes entirely concealed by superficial deposits. But at these breaks the series of ridges split up and spread out so as to cover an area from half a mile to ten or fifteen miles in width. It is in these localities that the complete geological structure of the country can be studied in detail. I do not know of any portion of the West where there is so much variety displayed in the geology as within a space of ten miles square around Colorado City. Nearly all the elements of geological study revealed in the Rocky Mountains are shown on a unique scale in this locality."

In studying the mines of Colorado the explorer noticed that the lodes are almost invariably parallel, running north-east to south-west. This and the two cleavage planes, one north-east to south-west, and the other north-west to south-east, which he found to be peculiar to all the Azoic rocks, leads to an important and highly interesting generalization:

"I am inclined to believe that the problem of the history of the Rocky Mountain ranges is closely connected with these two great sets of cleavage lines. As I have before stated, my own observations point to the conclusion that the general strike of the metamorphic ranges of mountains is north-west and south-east, and that the eruptive trend north-east and south-west. The dikes that sometimes extend long distances across the plains, in all cases trend north-east and south-west, or occasionally east and west. The purely eruptive ranges of the northern portion of the San Luis Valley seemed to be composed of a series of minor ranges "*en echelon*" with a trend north-east and south-west. But as soon as this range joins on to a range with a metamorphic or granitic nucleus, the trend changes around to north-west and south-east. Many of the ranges have a nucleus of metamorphic rocks though the central and highest portions may be composed of eruptive peaks and ridges. In this case the igneous material is thrust up in lines of the same direction as the trend. It becomes therefere evident that all the operations of the eruptive forces were an event subsequent to the elevation of the metamorphic nucleus. This is shown in hundreds of instances in Southern Colorado and New Mexico, where the eruptive material is oftentimes forced out over the metamorphic rocks, concealing them over large areas."

A GEOGRAPHICAL HANDBOOK OF ALL KNOWN FERNS, is the title of the latest and of the most praiseworthy of Fern-books, now so popular in England. This neat volume is by K. M. Lyell (Mrs. Col. Lyell), and is just published by Murray; a small octavo of two hundred and twenty-five pages. It gives in order, under the principal countries, a list of all their Ferns, with range and localities, and then a full series of tables exhibiting the geographical distribution of each species through the several regions.